Working Papers 2018 24

Bank shocks and firm performance: new evidence from the sovereign debt crisis

Luísa Farinha | Marina-Eliza Spaliara
Serafem Tsoukas

BANCO DE PORTUGAL
EUROSYSTEM

Working Papers 2018 24

Bank shocks and firm performance: new evidence from the sovereign debt crisis

Luísa Farinha | Marina-Eliza Spaliara
Serafem Tsoukas

DECEMBER 2018

Please address correspondence to
Banco de Portugal, Economics and Research Department
Av. Almirante Reis, 71, 1150-012 Lisboa, Portugal
Tel.: +351 213 130 000, email: estudos@bportugal.pt

BANCO DE PORTUGAL
EUROSYSTEM

Lisbon, 2018 • www.bportugal.pt

Working Papers | Lisbon 2018 • **Banco de Portugal** Av. Almirante Reis, 71 | 1150-012 Lisboa • www.bportugal.pt •
Edition Economics and Research Department • **ISBN (online)** 978-989-678-621-2 • **ISSN (online)** 2182-0422

Bank shocks and firm performance: New evidence from the sovereign debt crisis

Luísa Farinha
Banco de Portugal

Marina-Eliza Spaliara
University of Glasgow

Serafeim Tsoukas
University of Glasgow

December 2018

Abstract
Prior empirical investigations of corporate failures consider the effects of macroeconomic conditions and financial health, but the literature contains limited evidence of the real effects of the bank shocks caused by the sovereign debt crisis. Using a rich source of high-quality firm-bank matched data for 2005-2014, this study examines the real effects of bank shocks on firms' survival prospects in Portugal. We first present evidence that a funding outflow is associated with a reduction in the credit supply. Furthermore, firms borrowing from banks exposed to the funding outflow are more likely to fail. We also uncover significant heterogeneity in firms' financial positions and show that the negative effect of a funding shock is stronger for younger, higher-risk firms, and those that used their potential lines of bank credit.

JEL: F32, F34, G15, G21; E44

Keywords: Firm survival, Bank shocks, Sovereign debt crisis, Financial constraints.

Acknowledgements: We are grateful to the Editor and an anonymous referee for their very useful comments and suggestions. We would also like to thank Luciana Barbosa, Diana Bonfim, Martin Brown, Hans Degryse, Sudipto Karmakar, Sotirios Kokas, Steven Ongena, Alexander Michaelidis, John Rust, Michael Scharnagl, Sascha Steffen, Mark Wohar, and participants at the 2017 European Economic Association Conference, the 2017 European Association for Industrial Economics Conference,the 2017 EFiC Conference in Banking and Finance, the 2017 World Finance Conference, the 2018 International Conference on Macroeconomics and International Finance, the 2018 International Symposium in Finance, the Bank for International Settlements, the Bank of Serbia, Banco de Portugal, and the University of Essex for their comments on an earlier draft of this paper. The second and third authors gratefully acknowledge support from the Banco de Portugal and their generous hospitality during the period in which this paper was prepared. The views expressed in this paper are those of the authors and not necessarily the views of the Banco de Portugal or the Eurosystem. Any remaining errors are our own.

E-mail: lfarinha@bportugal.pt; marina.spaliara@glasgow.ac.uk;
serafeim.tsoukas@glasgow.ac.uk

1. Introduction

Financial health affects company failures, both according to theory and the existing empirical evidence. Clementi and Hopenhayn (2006)'s theoretical model predicts that financial constraints are important for survival and shows that the failure rate decreases with size and age.[1] Empirically, many studies examine firm survival from a financial perspective and conclude that firms' chances of survival respond strongly to a number of balance sheet indicators (Zingales (1998); Bunn and Redwood (2003); Bridges and Guariglia (2008) and Huynh et al. (2010)).[2] However, the literature remains relatively silent on whether shocks that have a strong impact on financial intermediaries can translate into real effects, especially in terms of survival prospects.[3]

Investigating the effect of bank shocks at the extensive margin is a key issue to understanding which types of firms are more exposed to extreme financial shocks. Such evidence is valuable for both policy-makers and academic researchers for several reasons. First, if efficient firms may still have to exit if they lack adequate access to finance, then this suggests an effect beyond the mechanism through which creative destruction works.[4] Second, bankruptcies destroy firms' value through under-investment and asset fire sales that simple downsizing does not.[5] Third, firm exits create unemployment with the adverse consequence of human capital depreciation. Fourth, aggregate employment recovers more slowly if firms exit than if they downsize (Bentolila et al. (2017)). Fifth, small and medium-sized enterprises (SMEs), which make up a large proportion of our sample, exit at an alarming rate (Mata and Portugal (1994)). Finally, it is possible that creditors will take longer to recover debt from exiting firms, and if they do they will likely recover a small fraction of that, which poses a difficulty for credit institutions. Considering these factors, it is therefore important to inform the debate on whether access to finance is likely to hinder the successful operations of non-financial firms.

To the best of our knowledge, our study is the first to investigate the impact of bank shocks on firms' chances of survival. Our empirical approach proceeds in two steps. We begin by assessing the response of banks exposed to funding

1. Conversely, the conditional probability of survival increases with the value of the firm's equity.

2. For example, Zingales (1998) uses data for the US trucking industry and shows that highly leveraged firms are less likely to survive. Other studies produce similar evidence for other industries and countries (see, for example, Bunn and Redwood (2003) and Bridges and Guariglia (2008) for UK manufacturing and services industries, Musso and Schiavo (2008) for French manufacturing firms, and Tsoukas (2011) for Asian companies).

3. Throughout the paper, we use the terms survival and failure interchangeably.

4. Schivardi et al. (2017) show that when lending is performed by under-capitalized banks, non-zombie firms are more likely to go bankrupt compared to their counterparts.

5. See Jackson (1986) on how financial distress raises the common pool problem, which then destroys company value.

shocks to the supply of credit to firms. Next, we investigate the consequences of deteriorating credit conditions for firms' survival prospects. Our premise is that firms borrowing from banks exposed to shocks should show a higher probability of failure. Drawing on a large matched firm-bank dataset from Portugal, we focus on a bank funding shock measured by interbank liabilities and deposit funding.[6] Moreover, we do not expect that a shock will affect all firms proportionally. We argue that heterogeneity in firms' financial positions is likely to play a critical role in amplifying the bank shocks. That is, we assess whether the effect of bank funding shocks on firm survival depends upon firm characteristics such as credit line drawdown activity, probability of default, and age.

Portugal, despite its smaller size than other European economies, warrants a thorough investigation for a number of reasons. First, the magnitude of the sovereign debt crisis, as evidenced by the sovereign debt spreads, is one of the largest in the euro area. Second, a large unanticipated shock hit the banking system and Portugal witnessed a substantial drop in the volume of new loans by 45% over the 2008-2013 period (see Acharya et al. (2018)).[7] Third, a large percentage of Portuguese firms are small according to the European Commission's criteria: only 1% are large and 85% are micro. Hence, SMEs in Portugal are heavily bank dependent, so the firms in our sample are unlikely to substitute bank credit from shocked banks with market finance. If anything, this is likely to intensify the real effects of the funding shocks. This can have important economic implications since smaller firms have a considerable weight in the Portuguese economy, with SMEs contributing around 55% of turnover and 75% of employment.[8] Fourth, Portugal recently changed its legislation on exit and restructuring barriers to allow prompt initiation of the insolvency or restructuring process (Gouveia and Osterhold (2018)). Therefore, the insolvency framework in Portugal is closer to that of international best practices (e.g., Chapter 11 in the US). Finally, we have access to a rich source of high-quality firm-bank matched data.

Our work contributes to the literature in three ways. First, we consider the transmission of funding shocks on firms' survival prospects. We thus speak directly to the literature on firm survival, which typically includes a set of financial variables in equations that model firm exits (see Zingales (1998); Bunn and Redwood (2003); Bridges and Guariglia (2008); and Huynh et al. (2010)). Our approach also complements the existing empirical literature on firm outcomes and lending shocks (see Chodorow-Reich (2014); Bottero et al. (2015); Cingano et al. (2016); Balduzzi et al. (2017); Bentolila et al. (2017);

6. In further empirical tests, we use banks' holdings of risky sovereign debt and Credit Default Swap (CDS) spreads as alternative instruments of shocks that affect the banking system.

7. The reduction in the loan supply in Europe was particularly severe in the later part of the sovereign debt crisis (Becker and Ivashina (2017)).

8. Authors' calculation using the Informcao Empresarial Simplicada (IES) database.

Dwenger et al. (2017); Popov and Rocholl (2017) and Acharya et al. (2018)), which highlights the real effects of bank balance sheet shocks at the firm level. Prior studies focus on exogenous shocks and their impact on real activities such as investment, asset growth, and employment. Our study completes the picture by looking at firm closures. As we argued above, this is an important consideration because firm closures were a major concern during the recent financial crisis. Firm survival and growth are important aspects of industry dynamics and form the competitive landscape in an economy. Moreover, we extend the existing line of work by considering different channels of transmission of shocks from the financial to the real sector. Specifically, we account for a funding outflow, banks' exposure to risky sovereign debt, and banks' CDS spreads.

The second main contribution is that we uncover significant heterogeneity in firms' financial positions. An extensive literature on firm heterogeneity posits that firms that face constraints in some financial markets are more likely to be associated with a higher degree of information asymmetry, and may therefore find it difficult to access external finance. Previous empirical studies on financing constraints emphasize the importance of size, age, and dividend payouts in firms' real activities.[9] In the financial intermediation literature, high risk firms and those with fewer tangible assets are relatively sensitive to bank capital shocks (Popov and Udell (2012)).[10] Balduzzi et al. (2017) use size and age to disentangle the effects of banks' financial market valuations on firms' decisions for different groups of firms. We build on this line of work by employing three indicators, namely credit line drawdowns, probability of default, and firms' age, to assess whether firms of various types respond to bank shocks differently.

Finally, we employ a rich, but relatively unexploited, firm-bank matched data set, combining data from the Portuguese Credit Register with Central Balance-sheet data. The latter collects annual financial statements for the period 2005-2014 on all non-financial corporations (around 500,000). This is a much broader sample of firms than prior studies use. Credit register records detailed monthly bank-firm level data on all loans by all credit institutions operating in Portugal. These data are essential for the analysis as they allow us to recover all existing bank-firm relationships and the corresponding amount of credit that flows over time. Therefore, we can show that a bank funding shock is uncorrelated with banks' ex-ante credit supply, and this is not driven by demand for bank loans. An appealing characteristic of the data set is

9. Size is the key proxy for capital market access by manufacturing firms in Gertler and Gilchrist (1994) because small firms are more vulnerable to capital market imperfections and are thus more likely to be financially constrained. In summary, these factors affect the corporate policies of financially constrained firms severely compared to their unconstrained counterparts.

10. Iyer et al. (2013) and Bentolila et al. (2017) provide evidence of micro-level heterogeneity for Portugal and Spain, respectively.

that it covers the universe of non-financial firms matched with the universe of banks, and our study therefore does not suffer from concerns about the representativeness of the data.

We present evidence that a negative bank funding shock is associated with a reduction in the credit supply. In other words, banks exposed to funding outflows subsequently tighten credit conditions for the same borrower relative to less affected banks. We next show that this shock is transmitted to the real sector, paying special attention to firm closures. We show that firms that maintain a pre-crisis relationship with banks that experience a larger funding outflow are more likely to fail, all else being equal. In addition, we document alternative channels of transmission from banks to firms, which may be helpful in identifying banks that are more vulnerable to adverse financial events by focusing on banks' exposure to sovereign debt and their CDS spreads.

In addition, we find a noticeable negative effect of being financially constrained on the probability of firm exit. When we consider firm heterogeneity, we find that a firm's degree of financial constraints is a critical determinant of real responses to funding shocks. We interact funding shocks with a set of firm characteristics and show that the negative effect of the various shocks on the hazard of exit is more potent for firms that used their lines of credit, have a higher probability of default, and are younger. Overall, our evidence provides a key contribution to the literature on firm survival, bank lending, and financial shocks.

The remainder of the paper proceeds as follows. Section 2 presents a brief summary of the relevant literature. Sections 3 and 4 describe our methodology and dataset, respectively. Section 5 presents the empirical results. Section 6 reports the robustness tests and Section 7 concludes.

2. Related literature

A quickly evolving line of work investigates the impact of recent crises on firms' real decisions. Existing evidence on this area is relatively scarce due to the limited data available for firm-bank relationships, as well as that for financial information for both firms and banks. Prior works initially identify the real effects of the credit supply at the aggregate level or on sub-samples of listed companies (see Peek and Rosengren (2000); Campello et al. (2010); Almeida et al. (2012) and Amiti and Weinstein (2017)).

At the firm-level, Bentolila et al. (2017) show that firms attached to weaker banks that were eventually bailed out by the Spanish government suffered a larger fall in employment. Bottero et al. (2015) find that following the Greek bailout in 2010, financial intermediaries exposed to government securities reduced credit, affecting smaller Italian firms' investment and employment decisions. Acharya et al. (2018) investigate the impact of the sovereign debt crisis on corporate policies using syndicated loan data. Their evidence suggests

that the loan supply contraction of GIIPS banks depresses investment, job creation, and sales growth of European borrowers with a significant business relationship with these banks.

In the context of the global financial crisis, Chodorow-Reich (2014) shows that U.S. bank exposure to the Lehman bankruptcy had a sizable influence on employment for SMEs that had pre-crisis relationships with less healthy lenders. Cingano et al. (2016) exploit the 2007 liquidity drought in interbank markets and document that the credit shock following this crisis affected Italian firms' investment spending and employment. In addition, the effect proved stronger among small and young firms, as well as those that are heavily bank dependent. Moreover, De Jonghe et al. (2016) show a moderate drop in investment and asset growth for firms in Belgium that borrow from banks affected by a funding shock.

Balduzzi et al. (2017) analyze the effects of banks' financial market valuations on firms' decisions, such as investment and employment. They study both the financial and sovereign debt crises and find evidence of significant adverse credit-channel effects of the two crises. Finally, Popov and Rocholl (2017) and Dwenger et al. (2017) show that exogenous funding shocks affect labor decisions. Both studies focus on Germany and conclude that firms associated with banks affected by the U.S. subprime mortgage crisis experienced a significant decline in employment.

3. Empirical implementation

3.1. Identification issues

Our main goal in this study is to identify how bank shocks affect firms' performance. We tackle this issue by first assessing the response of banks exposed to a funding shock to the supply of credit to firms. The main challenge in this context is to isolate credit supply effects from other economy-wide trends. We base our identifying assumption on two important requirements. First, the bank funding shock must be uncorrelated with banks' ex-ante credit supply. Second, to correctly identify credit supply effects, we must rule out the possibility that demand for bank loans drives the analysis.

For the first requirement, we argue that the sovereign debt crisis was an unanticipated shock that hit the Portuguese banking system. The Greek events fundamentally and unexpectedly changed market participants' risk appetite for sovereigns and made them more cautious about the quality of their fundamentals. This led to a sharp increase in the spreads of bond yields in peripheral European countries. The lack of confidence and the uncertain economic climate surrounding Greece's financial situation raised concerns about Europe's economic stability and the possibility of a contagion in other European economies. Thus, Portuguese banks suddenly lost access to international

medium- and long-term wholesale debt markets, which were an important source of funding (Alves et al. (2016)). Importantly, the crisis in the Portuguese banking system did not originate from a domestic real estate bubble. Therefore, loses on mortgages did not adversely affect banks and firms did not witness substantial reductions in commercial property prices. The upshot is that an exogenous and unanticipated shock affected the balance sheets of Portuguese banks.

To identify the credit supply, we use the exhaustive credit register managed by the Banco de Portugal, and match this data with firm- and bank-level balance sheet data. We select firms that have a relationship with more than one bank and include firm fixed effects to control for firm-specific loan demand effects following Khwaja and Mian (2008). In our sample, 82% of firms have multiple bank relationships, which is a common feature in other comparable data sets used in prior studies of Portugal and elsewhere (see Alves et al. (2016) and Degryse et al. (2009)).[11] [12] Finally, to mitigate endogeneity concerns further, we include all bank and firm variables at their levels prior to the bank funding shock.

3.2. Credit supply

To identify the real effects of the bank lending channel, we must account for the credit supply effects at the bank-firm level. We follow the established empirical literature on credit supply using the Khwaja and Mian (2008) technique to identify the effect of a bank liquidity shock on credit supply, considering the observed and unobserved determinants of credit demand.[13] The underlying idea of this approach is that we can use detailed credit register data to focus on a sample of firms with bank relationships and regress credit growth at the bank-firm level on the bank funding shock and a set of bank-specific characteristics while controlling for credit demand by including a set of firm fixed effects. We estimate the following equation:

$$\Delta L_{ib} = \beta_1 BankShock_{ib} + \beta_2 Y_b + \alpha_i + \varepsilon_{ib} \tag{1}$$

where the dependent variable is the firm-bank logarithmic difference between the post-shock and pre-shock average values of credit granted to firm i by bank b. *Bank Shock* represents the funding shock measured at the

11. We also follow De Jonghe et al. (2016) to construct location-sector-size fixed effects to consider both single and multiple bank relationships. Our results were robust to this modification.

12. Farinha and Santos (2002) use Portuguese data and find that firms with greater growth opportunities, less liquidity, or greater bank dependence are more likely to switch to multiple bank relationships.

13. Other studies that use this approach include Amiti and Weinstein (2011), Degryse et al. (2016), and Cingano et al. (2016).

relationship level. Following De Jonghe et al. (2016), we define the shock as the average value of interbank liabilities plus deposits in 2011 (post-shock) minus the average value in 2009 (pre-shock), scaled by the average total assets pre-shock. We calculate the weighted funding shock using the share of each bank in a firm's loan portfolio in 2009. Y is a vector of time-averaged pre-determined bank-specific covariates such as size, non-performing loans (NPLs), and lending relationships (see the appendix for detailed definitions). α_i is a firm fixed effect that controls for all observed and unobserved heterogeneity (firm-level credit demand, firm quality, riskiness, etc.). In this context, we can separate credit demand from credit supply and the coefficient on β_1 indicates the extent to which banks with varying degrees of funding outflows reduced their credit growth to the same borrower. Finally, we cluster the standard errors at the bank level.

3.3. Firm survival

To quantify the real effects of the funding shock on firms' hazard of exit, we estimate regressions of firm survival as a function of the funding shock as well as firm and bank financial variables. We initially estimate the following model:

$$Pr(Fail_i = 1) = F(a_0 + a_1 BankShock_{ib} + a_2 X_i + a_3 Y_b + v_s + \varepsilon_i) \quad (2)$$

where *Fail* is a dummy variable that equals 1 if firm i exits between 2009 and 2011, and 0 otherwise. We follow the empirical literature on firm survival and identify a firm exit as a firm closure. We find the time of exit by identifying the moment at which firms cease to report IES information. We require that a firm is absent from the survey for at least two years to identify an exit because temporary non-reporting may occur for reasons besides cessation of activity.[14] $F(.)$ denotes the standard normal distribution function. Vectors X and Y denote a set of firm and bank control variables, respectively, that are likely to influence a firm's chances of survival. v_s is a set of industry fixed effects to control for industry-specific changes. The standard errors are clustered at the bank level. In addition, we control for all observed and unobserved firm heterogeneity (including changes in firm-specific credit demand) using estimates of firm fixed effects (α_i) from Model (3.1), as in Bonaccorsi and Sette (2016) and Cingano et al. (2016).

14. While we are unable to distinguish exits from mergers and acquisitions (M&As) due to the nature of the data, we note that the latter represents a very small fraction in the data. According to Banco de Portugal statistics, M&As over the sample period range from 0.8% to 2% of all firm exits. Given that M&A are typically observed for larger firms (Moeller et al. (2004)) and our data consists mainly of micro firms and SMEs, we expect to cover a negligible fraction of M&A in our data.

3.4. Firm characteristics

In vector X, we control for several firm-specific characteristics that have an important influence on corporate failures. We first introduce $Size$ as the logarithm of the firm's real total assets. Next, we add Age as the number of years since the date of incorporation.[15] In addition, we include a set of balance sheet variables that capture of financial health. We control for $Leverage$, as measured the firm's long-term debt to total assets, $Collateral$, calculated as the ratio of tangible assets to total assets, and the $Z-score$, which is a bankruptcy risk indicator. We expect larger, older firms and those in better financial shape to be associated with a lower likelihood of exit.

3.5. Bank characteristics

We follow the literature and control for several bank-specific characteristics in vector Y. We define $Bank\ size$ as the logarithm of the bank's total assets. Next, we control for non-performing loans (NPL) by taking the loans that are in default as a fraction of the bank's total assets. We expect to see a negative relationship between bank size and firms' chances of failure, and a positive association between NPL and firms' propensity to fail. We also examine the role of firm-bank relationships by including two dummy variables: the $New\ lending$ relationship and $Term.\ lending$. The former accounts for new relationships, while the latter captures the termination of an existing relationship. We should expect an increase in new credit to be a good signal for the firm's creditworthiness, which in turn might have a positive impact on firm performance. Further, small and illiquid banks and those with high NPL are more likely to terminate an existing relationship with a company. Thus, a rise in the level of lending termination should have a negative effect on our dependent variable.

3.6. The role of firm heterogeneity

In this section, we explore how firm heterogeneity is likely to affect the impact of funding shocks on firm exits. We hypothesize that banks may allocate credit to firms according to their overall performance, and therefore, non-linearities may be present. To test this hypothesis, we split our firms using three sorting devices. First, we rely on credit lines to study credit line drawdown activity. We can identify firms with outstanding and undrawn credit lines on a monthly basis. The literature on credit lines suggests that bank credit lines can work as substitutes for internal funds by allowing firms to access a certain amount of pre-committed financing in exchange for paying a commitment fee (see Almeida

15. In untabulated regressions, we employ $SIZE^2$ and AGE^2 to control for non-linear effects, and this does not change our main findings.

et al. (2014)). Credit lines can be thought of as a source of liquidity (Lins et al. (2010) and Tsoukalas et al. (2017)) because they can help firms to weather adverse economic events (Campello et al. (2011)). In our context, credit line drawdown is likely to reflect a firm's demand for credit. As such, we can see credit line drawdown activity as an additional layer of erogeneity that can provide a cleaner identification in our models.

Next, we split firms according to their probability of default using their z-scores. We can employ the z-score, to not only assess whether there is a differential effect of bank funding shocks on firm exits based on riskiness, but also to control for loan evergreening.[16]

We also sort firms based by age according to the time elapsed since the firm's incorporation. The extant literature on financial constraints concludes that younger firms are more vulnerable to credit shocks due to lower transparency, lack of a track record or reputation, or limited ability to pledge collateral (Gertler and Gilchrist (1994)).

Our models include interactions of the bank shock with a dummy variable ($Dummy$) indicating the firms that maxed out their lines of credit, high risk, or young firms. For the credit line variable, the dummy takes the value one if a firm took all credit available before the shock. For the z-score, the dummy for riskier firms takes the value one if the pre-shock z-score is above the median z-score of all firms in their particular industry and year. The dummy variable for younger firms takes the value one if the pre-shock age is below the median age of all firms in their particular industry and year.[17] We set all variables in the pre-shock period (i.e., predetermined with respect to the 2010 sovereign debt crisis). We augment model (3.2) as follows:

$$Pr(Fail_i = 1) = F(a_0 + a_1 BankShock_{ib} * Dummy_i + a_2 BankShock_{ib} * (1 - Dummy_i) + a_3 X_i + a_4 Y_b + v_s + \varepsilon_i) \quad (3)$$

If the results confirm our hypothesis, then when banking funding shock occurs, we should expect high risk, young firms, and firms that have drawn down their credit lines to be more severely affected than their counterparts are. Therefore, the coefficients associated with $Bank\ Shock^*(1 - Dummy)$ should be smaller than those associated with $Bank\ Shock^*Dummy$.

16. In particular, some banks provide credit to "bad" firms to avoid loan defaults, even if banks consider these firms as the weakest borrowers (see, e.g., Albertazzi and Marchetti (2010)).

17. Our results are robust to using different cut-off points for the grouping criteria.

4. Data and summary statistics

4.1. Data description

We use proprietary administrative data from the Portuguese central bank. This data contains detailed, high-quality matched firm-bank information. We have data on credit relationships and balance sheets for both firms and banks before and after the sovereign debt crisis. We collect our data from three main sources.

We rely on the Central Credit Register (CRC) of Banco de Portugal to obtain loan-level information for the period 2005 to 2014. This comprehensive data set records all loans granted to non-financial companies by all banks operating in Portugal. The threshold for reporting loan information is 50 euros; hence, the credit register records the universe of outstanding loans to corporations and individuals. This database contains information about the amount of the loan and its type, namely if it is in a regular situation, renegotiated, overdue or potential.

We combine credit register data with two other data sources. First, at the bank level we merge credit register with bank balance sheet data, from which we extract bank characteristics such as size, profitability, liquidity, credit risk and interbank borrowing. The bank-level data are reported at a monthly frequency. Second, at the firm level, we merge the data with firm annual balance-sheet data, from which we obtain firm-specific characteristics such as size, age, leverage and collateral. Following normal selection criteria used in the literature, we exclude companies with incomplete data for our explanatory variables and firm-years with negative sales. To control for the potential influence of outliers, we remove observations in the one percent of the upper and lower tails of the distribution of the regression variables. Our panel includes 1,590,203 firm-bank observations with 492,208 firms.

4.2. Sample analysis

Table A.1 presents the descriptive statistics for the variables used in the regression models as a preliminary analysis. We report these values for the whole sample. Over the sample period, the statistics show that the average bank shock is equal to -3.9%, indicating an outflow, while the average growth in credit granted is positive, at 0.3% with a cross-sectional variation according to the standard deviation, which is 4.79%. The latter statistic indicates that some firms experienced a substantial drop in credit exposure, while others increased their uptake of credit. Moving to the extensive margin of credit, we observe that 36.3% of the bank-firm relationships were new, meaning that they did not exist before the shock. We also observe that 24% of the bank-firm relationships were terminated before the shock.

The middle panel of Table A.1 reports the bank-level summary statistics. The bottom panel reports the firm-level statistics. At the firm-level, our data

set consists of more than 330,000 firm-year observations. The exit rate for firms in Portugal during the sample period is 27%, implying a relatively high number of exits.[18] In addition, the average firm in our sample is sixteen years old, with a median of thirteen years. The mean leverage ratio is 24.6% with a median of 20.2%. Finally, the average firm is well collateralized, with a ratio of 28%.

Figure A.1 illustrates the evolution of firm exits over the sample period, and distinguishes between firms with above- and below-median exposure to the bank shock. The figure shows that firms exposed to the funding outflow experienced consistently higher failures compared to their counterparts. Moreover, the gap between the two groups further widened from 2010 onwards.

5. Results

5.1. Credit supply

A basic premise of this study is that the European (sovereign) debt crisis created significant loan disruptions in Portugal. To assess this claim, we begin by estimating models of credit supply growth at the bank-firm level. In other words, we evaluate the variation in credit growth from banks with differing exposure to the funding shock to the same firm. Table A.2 reports the findings on the effect of a funding outflow on credit growth. As we mentioned above, we separate credit demand from credit supply using firm fixed effects following Khwaja and Mian (2008).

Columns 1-3 report the results when we include the funding shock, add bank-specific characteristics, and quantify the additional effects of bank shocks according to the potential for bankruptcy using the firms' z-scores.[19] The findings point to a strong reduction of credit growth following a funding outflow, since the coefficients on all models are highly statistically significant. Specifically, firms that borrow from banks affected by a funding outflow face a tighter credit supply. This finding is significant, not only statistically, but also economically: given that the total amount of credit granted before the shock was 82 billion euro, the point estimate of 1.47 implies a reduction in credit to the average firm by 5.7 percent. Hence, this translates into a drop in credit availability of 4.7 billion euro. This finding is in line with De Jonghe et al. (2016), who show a similar reduction in credit growth in Belgium following the collapse of Lehman Brothers. However, we base our analysis on a much broader sample compared to the study in Belgium, and our study includes micro and small firms, which are likely to be bank-dependent. In sum, we show that highly

18. The evolution of failure rates, however, as Figure A.1 shows, is in line with those in Bulletin (2017)

19. We have to drop firm fixed effects to include firms' z-scores in the lending equation.

affected banks that experience a funding outflow reduce lending to the same borrower more relative to less affected banks. Therefore, consistent with our expectations and findings from prior studies, negative funding shocks adversely affect banks' supply of credit.

5.2. Firm performance

In this section, we examine the role of a funding shock in firms' survival. We first estimate a baseline model of business failure as in Equation (3.2). Table A.3 reports the results. In column 1, we report the results without controlling for credit demand, while in column 2, we follow Bonaccorsi and Sette (2016) and Cingano et al. (2016) and control for credit demand by incorporating the firm-level dummies estimated in the credit supply regressions reported in Table A.2. Our results remain unchanged after including a control for credit demand. Finally, in column 3, we augment the model with a firm's risk of bankruptcy using its z-score.

The point estimates on bank shock suggest a robust relationship between the funding shock and the chances of firm failure. The bank shock has a positive and highly significant coefficient for all models reported in the table, which clarifies the impact of a ceteris paribus bank shock on the hazard of exit. The results show that firms borrowing from banks that experience a funding shock are more likely to face a higher probability of exit. In terms of economic magnitude the marginal effect of the coefficient on a bank funding shock, as column 2 of Table A.3 shows, indicates that the average firm in our sample that borrowed from a bank that experienced an outflow of 3.9%, faced an increase in the probability of failure of 1.72 percentage points. This supports our hypothesis that an exogenous shock to the bank supply, such as the European sovereign debt crisis, negatively affects firms' chances of survival. Put differently, firms borrowing from banks exposed to a funding outflow are more likely to exit.

Next, we focus on the firm-specific control variables. The coefficients of *Size*, *Age*, and *Leverage* are all mostly significant and precise. Larger and older firms are less likely to exit, consistent with Mata and Portugal (1994); Audretsch and Mahmood (1995); and Dunne et al. (1998). We also document that leverage is positively associated with the probability of exit, implying that firms with high debt levels have lower chances of survival. Overall, these findings show that firm health plays a crucial role. Our results are in line with several studies that highlight the role of the balance sheet position in corporate outcomes (see, e.g., Zingales (1998); Clementi and Hopenhayn (2006); and Tsoukas (2011)).

In terms of the bank-specific characteristics, we find that firms that terminated their lending relationships as of 2009 are associated with higher chances of firm exit. We also see evidence that firms that established a new lending relationship before the shock are more likely to fail. Finally, a higher level of NPLs is related with an increased probability of firm exit.

In summary, our results so far suggest that firms associated with banks that experienced a larger funding outflow are likely to face an increased hazard of failure. This new result complements earlier work and highlights the role of bank shocks in the real effects of the sovereign debt crisis in Portugal.

5.3. Are firms affected proportionally?

We now consider the impact of financial constraints on the response to bank shocks. No prior study as of yet addresses this question using firm-bank data for firms' survival prospects. Table A.4 presents the estimates for the interaction terms between a bank shock and financial constraint dummies. The results, which are remarkably consistent across the constraint categories, reveal heterogeneity between firms that the estimates for the full sample do not show. In the first column, we report point estimates using bank credit lines as a sorting device, while in the subsequent columns, we rely on z-score and age. A bank shock negatively influences survival chances for constrained firms, but does not do so for unconstrained firms, for which we find an insignificant relationship in two out of three cases. In other words, we find that a bank shock is likely to increase the chances of exit more for firms that maxed out their credit lines, are riskier, and are younger compared to their counterparts. Based on the extracted marginal effects, the impact of a funding shock of 3.9% leads to an increased probability of failure of 1.85 percentage points for firms that used their credit lines or of 1.92 percentage points for high risk companies.[20] This may be because financially constrained firms are associated with a higher degree of information asymmetry and are less able to find alternative sources of finance when they borrow from banks that are strongly affected by a funding shock.

We conclude that the hazard of exit increases for financially constrained firms when they borrow from banks exposed to funding shocks, but unconstrained firms remain unaffected. In addition, the point estimates across the interaction terms are significantly different from each other for all three classification methods. Finally, the other variables show the expected signs and retain their significance in most cases.

6. Robustness checks

6.1. CDS spreads

We now shift our attention to banks' CDS spreads as a market instrument of their financial health. Balduzzi et al. (2017) show that increases in banks' CDS

20. We do not calculate the economic importance for the interaction terms with the unconstrained group of firms because they do not differ statistically from zero.

spreads affect client firms' credit supply conditions, and thus their employment and investment prospects. In the same spirit, we re-estimate our survival equations to check whether financial market valuations capture crisis-related shocks.[21] We obtain data for three banking groups that correspond to eight banks in Portugal.[22]

Tables A.5 and A.6 report the results. We first confirm that firms associated with banks that faced an increase in their CDS spreads were more likely to exit. Therefore, banks' financial valuations contain information about the cost of funding and have a strong effect on firm exits. We then explore firm heterogeneity and find that both types of firms respond strongly to CDS spreads. Tests of equality suggest that the interaction terms are significantly different from each other in two out of three cases. Thus, overall, we confirm that our results are robust to an alternative shock based on market valuations.

6.2. Sovereign exposure

We explore an alternative channel of shock transmission from the financial to the real sector, namely, the sovereign debt channel to consider banks' sovereign holdings as a fraction of their total assets to measure sovereign exposure. Some previous studies use similar measures of firm exposure to the sovereign through its lenders (Bottero et al. (2015); Barbosa (2017); and Buera and Karmakar (2018)).

We re-estimate models (3.2) and (3.3) and report the results in Tables A.7 and A.8. To begin with the direct effect of sovereign exposure in Table A.7, we find that firms borrowing from institutions with greater sovereign exposure experience a higher probability of failure. This indicates that the heightened uncertainty and market tensions in the euro area sovereign debt markets and the sharp increases in sovereign bond yields had a real impact on company failures. Further, when we split our sample into financially constrained and unconstrained groups in Table A.8, we find that firm-level heterogeneity persists. In summary, our main results are robust to an alternative channel of shock transmission from the financial to the real sector through banks' holdings of sovereign debt.

6.3. Additional tests

We conduct four additional tests of the results we report in the main section. We summarize these additional robustness tests below, but do not report them due to space constraints. They are available upon request.

21. The CDS market in Portugal is relatively illiquid since the largest Portuguese Banks are smaller relative to the largest European.

22. The CDS data come from Reuters.

First, to confirm that our findings are not driven by the construction sector, which is inherently riskier, we reproduce the models after removing firms that operate in this industrial group.[23] All significant point estimates remain within the same confidence interval and retain their level of significance. Thus, we conclude that including the construction sector in our sample does not bias our results in any way.

Second, we perform a placebo experiment to test for an underlying trend before the sovereign debt crisis. We use 2008 as a fictitious shock period for which the true effect of funding outflows is zero. Our results demonstrate an insignificant impact of the bank shock on firm exits. We find this quantitatively unimportant result for both constrained and unconstrained firms. In sum, the placebo tests confirm the validity of the identification strategy, supporting the common trend assumption.

Third, we examine whether the European Banking Authority's (EBA's) sovereign capital buffer can perhaps have a bearing on our findings. We refer to the EBA's October 2011 unexpected increase in the minimum levels of the Core Tier 1 ratio to 9% by the end 2011 and 10% by the end of 2012. The timing of the exercise was unexpected, as the EBA conducted a round of stress tests in July 2011 (see Gropp et al. (2018)). Only a sub-set of Portuguese banks were subject to the EBA intervention and had to meet these criteria.[24] To this effect, we now investigate whether the deleveraging of the financial sector by reinforcing banks' capital positions is likely to have an effect on firm survival.[25] The results show that the introduction of the EBA policy increased the firm-level probability of exit within the treated group (banks exposed to the EBA policy change) compared to their control counterparts. In addition, when we split our firms into different groups, we find that financially constrained firms affected by the policy change face an increased probability of failure compared to similar firms in the control group.

Finally, we check whether our main results are robust to using a linear probability model, which is known to perform better in the presence of a large number of fixed effects. We show that the point estimates are quantitatively and qualitatively very similar to those obtained from the probit model. We conclude therefore that our main findings are robust to using an alternative estimator.

23. According to Financial Stability (2012) "these sectors (construction and real estate) jointly represent around 34 per cent of total loans to non-financial corporations and account for a far higher proportion of non-financial corporations defaults (around 56 per cent)".

24. In Portugal, the EBA's rules affected four banking groups (containing 7 banks), namely CGD, Banco BPI, BCP, and ESFG.

25. Previous studies show that increasing the level of capital requirements is likely to reduce bank lending (Brun et al. (2017) and Jiménez et al. (2017)).

7. Conclusion

Both academics and policy makers seek to understand the determinants of company closures, with a focus on balance sheet characteristics and macroeconomic indicators. However, they pay considerably less attention to the potential role of bank shocks that may transmit to the real sector. This is somewhat surprising given the large number of firm exits during the recent financial crisis. In addition, firm exits contribute negatively to changes in the amount of debt registered on the financial institutions' balance sheet. Our study builds on these foundations, but focuses on bank shocks and their real effect on firm exits. Using panel data for firm-bank matched data in Portugal, we find that banks experiencing a negative funding shock significantly reduced credit to firms. Importantly, deteriorating credit conditions had a real effect. We show that firms borrowing from banks that experienced a funding outflow have a higher probability of exit.

We next investigate whether the effect of bank funding shocks on firm survival depends upon firm characteristics such as credit line drawdown activity, probability of default, and age. When we split our firms according to these criteria, we uncover significant firm-level heterogeneity. In particular, the negative effect of a funding shock is stronger for young firms, risky firms, and firms that used their potential lines of bank credit. This implies that bank shocks do not affect all firms equally, reflecting the higher risk characteristics associated with different types of firms, namely those that are financially constrained and subject to greater information asymmetries. Our results are robust to alternative transmission channels of shocks from the financial to the real sector, such as banks' exposure to sovereign debt and their financial health.

Our results have important policy implications. If access to credit is one factor that could shield firms against closure and poor performance, then promoting policies aimed at making low cost credit readily available to financially constrained, but viable, firms should be high on the policy maker's agenda.

References

Acharya, V., Eisert, T., Eufinger, C. and Hirsch, C.: 2018, Real effects of the sovereign debt crisis in Europe: Evidence from syndicated loans, *forthcoming in Review of Financial Studies*.

Albertazzi, U. and Marchetti, D.: 2010, Credit supply, flight to quality and evergreening: An analysis of bank-firm relationships after Lehman, *Working paper 756, Bank of Italy*.

Almeida, H., Campello, M., Cuhna, I. and Weisbach, M.: 2014, Corporate liquidity management: A conceptual framework and survey, *Annual Review of Financial Economics* 6, 135-162.

Almeida, H., Campello, M., Laranjeira, B. and Weisbenner, S.: 2012, Corporate debt maturity and the real effects of the 2007 credit crisis, *Critical Finance Review* 1, 3-58.

Alves, N., Bonfim, D. and Soares, C.: 2016, Surviving the perfect storm: The role of the lender of last resort, *Working paper No 17, Banco de Portugal*.

Amiti, M. and Weinstein, D.: 2011, Exports and financial shocks, *Quarterly Journal of Economics* 126, 1841-1877.

Amiti, M. and Weinstein, D.: 2017, How much do idiosyncratic bank shocks affect investment? Evidence from matched bank-firm loan data, *Journal of Political Economy* 126, 525-587.

Audretsch, D. and Mahmood, T.: 1995, New firm survival: New results using a hazard function, *Review of Economics and Statistics* 97, 97-103.

Balduzzi, P., Brancati, E. and Schiantarelli, F.: 2017, Financial markets, banks' cost of funding, and firms' decisions: Lessons from two crises, *forthcoming in Journal of Financial Intermediation*.

Barbosa, L.: 2017, Lending relationships and the real economy: Evidence in the context of the Euro area sovereign debt crisis, *Working paper number 8, Bank of Portugal*.

Becker, B. and Ivashina, V.: 2017, Financial repression in the European sovereign debt crisis, *Review of Finance* 22, 83-115.

Bentolila, S., Jansen, M., Jiménez, G. and Ruano, S.: 2017, When credit dries up: Job losses in the great recession, *Journal of the European Economic Association* 16, 650-695.

Bonaccorsi, E. and Sette, E.: 2016, Did the securitization market freeze affect bank lending during the financial crisis? Evidence from a credit register, *Journal of Financial Intermediation* 25, 54-76.

Bottero, M., Lenzu, S. and Mezzanotti, F.: 2015, Sovereign debt exposure and the bank lending channel: Impact on credit supply and the real economy, *Working paper 1032, Bank of Italy*.

Bridges, S. and Guariglia, A.: 2008, Financial constraints, global engagement, and firm survival in the UK: Evidence from micro data, *Scottish Journal of Political Economy* 55, 444-464.

Brun, M., Fraisse, H. and Thesmar, D.: 2017, The real effects of bank capital requirements, *Working paper number 47, European Systemic Risk Board*.

Buera, F. and Karmakar, S.: 2018, Real effects of financial distress: The role of heterogeneity, *Working paper number 6, Bank of Portugal*.

Bulletin, E.: 2017, Economic bulletin, *Bank of Portugal, May*.

Bunn, P. and Redwood, V.: 2003, Company accounts based modelling of business failures and the implications for financial stability, *Working Paper 210, Bank of* E*ngland*.

Campello, M., Giambona, E., Graham, R. and Campbell, H.: 2011, Liquidity management and corporate investment during a financial crisis, *Review of Financial Studies* **24**, 1944-1979.

Campello, M., Graham, J. and Harvey, C.: 2010, The real effects of financial constraints: Evidence from a financial crisis, *Journal of Financial Economics* **97**, 470–487.

Chodorow-Reich, G.: 2014, The employment effects of credit market disruptions: Firm-level evidence from the 2008-9 financial crisis, *Quarterly Journal of Economics* 129, 1-59.

Cingano, F., Manaresi, F. and Sette, E.: 2016, Does credit crunch investment down? New evidence on the real effects of the bank-lending channel, *Review of Financial Studies* 29, 2737-2773.

Clementi, L. and Hopenhayn, H.: 2006, A theory of financing constraints and firm dynamics, *Quarterly Journal of Economics* 54, 229-265.

Degryse, H., De Jonghe, O., Jakovljevic, S., Mullier, K. and Schepens, G.: 2016, The impact of bank shocks on firm-level outcomes and bank risk-taking, *Mimeo, Available at SSRN 2788512*.

Degryse, H., Kim, M. and Ongena, S.: 2009, Microeconometrics of banking methods, applications, and results, *Oxford University Press*.

De Jonghe, O., Dewachter, H., Mullier, K., Ongena, S. and Schepens, G.: 2016, Some borrowers are more equal than others: Bank funding shocks and credit reallocation, *Mimeo, University of Ghent*.

Dunne, T., Roberts, M. and Samuelson, L.: 1998, Patterns of firm entry and exit in US manufacturing industries, *Rand Journal of Economics,* 19, 495-515.

Dwenger, N., Fossen, F. and Simmler, M.: 2017, Firms' financial and real responses to credit supply shocks: Evidence from firm-bank relationships in Germany, *forthcoming in Journal of Financial Intermediation*.

Financial Stability: 2012, Financial Stability Report, November, Chapter 4. Credit Risk.

Farinha, L. and Santos, J.: 2002, Switching from single to multiple bank lending relationships: Determinants and implications, *Journal of Financial Intermediation* 11, 124-151.

Gertler, M. and Gilchrist, S.: 1994, Monetary policy, business cycles, and the behavior of small manufacturing firms, *Quarterly Journal of Economics* **109**, 309-340.

Gouveia, A. and Osterhold, C.: 2018, Fear the walking dead: zombie firms, spillovers and exit barriers, *Working Paper 11*, Banco de Portugal.

Gropp, R., Mosk, T., Ongena, S. and Wix, C.: 2018, Bank response to higher capital requirements. Evidence from a quasi-natural experiment, *forthcoming in Review of Financial Studies*.

Huynh, K., Petrunia, R. and Voia, M.: 2010, The impact of initial financial state on firm duration across entry cohorts, *Journal of Industrial Economics* **58**, 661-689.

Iyer, R., Peydro, J.-L., da Rocha-Lopes, S. and Schoar, A.: 2013, Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007—2009 crisis, *Review of Financial Studies* 27, 347-372.

Jackson, T.: 1986, *The logics and limits of bankruptcy law*, Harvard University Press.

Jiménez, G., Ongena, S., Peydro, J.-L. and Saurina, J.: 2017, Macroprudential policy, countercyclical bank capital buffers and credit supply: Evidence from the Spanish dynamic provisioning experiments, *Journal of Political Economy* 125, 2126-2177.

Khwaja, A. and Mian, A.: 2008, Tracing the impact of bank liquidity shocks: Evidence from an emerging market, *American Economic Review* 98, 1413-1442.

Lins, K., Servaes, H. and Tufano, P.: 2010, What drives corporate liquidity? An international survey of cash holdings and lines of credit, *Journal of Financial Economics* 98, 160-176.

Mata, J. and Portugal, P.: 1994, Life duration of new firms, *Journal of Industrial Economics* 27, 227-243.

Moeller, S., Schlingemann, F. and Stulz, R.: 2004, Firm size and the gains from acquisitions, *Journal of Financial Economics* 73, 201-228.

Musso, P. and Schiavo, S.: 2008, The impact of financial constraints on firm survival and growth, *Journal of Evolutionary Economics* 18, 135-149.

Peek, J. and Rosengren, E.: 2000, Collateral damage: Effects of the Japanese bank crisis on real activity in the United States, *American Economic Review* 90, 30-45.

Popov, A. and Rocholl, J.: 2017, Do credit shocks affect labor demand? Evidence from employment and wages during the financial crisis, *forthcoming in Journal of Financial Intermediation*.

Popov, A. and Udell, G.: 2012, Cross-border banking, credit access, and the financial crisis, *Journal of International Economics* 87, 147-161.

Schivardi, F., Sette, E. and Tabellini, G.: 2017, Credit misallocation during the European financial crisis, *Working Paper 669*, Bank for International Settlements.

Tsoukalas, J., Tsoukas, S. and Guariglia, A.: 2017, To what extent are savings-cash flow sensitivities informative to test for capital market imperfections?, *Review of Finance* 21, 1251-1285.

Tsoukas, S.: 2011, Firm survival and financial development: Evidence from a panel of emerging Asian economies, *Journal of Banking and Finance* 35, 1736-1752.

Zingales, L.: 1998, Survival of the fittest or the fattest? Exit and financing in trucking industry, *Journal of Finance* 53, 905-938.

Appendix: Figures and tables

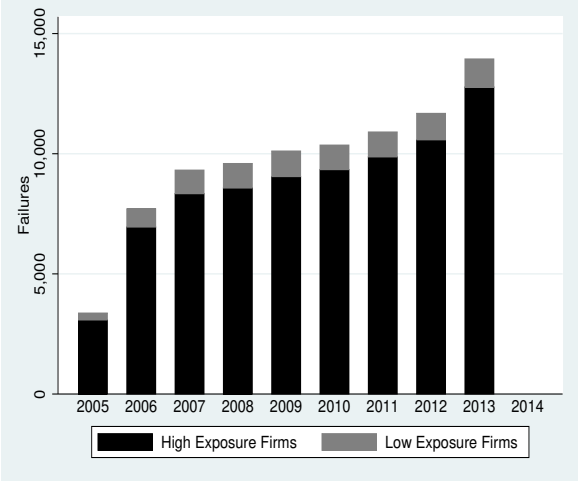


FIGURE A.1: Number of failing firms by bank exposure

	Obs	Mean	StDev	p25	Median	p75
Bank-firm level						
Bank Shock	1,590,203	-0.039	0.075	-0.107	-0.032	0.028
ΔL	1,590,203	0.003	4.791	-6.597	0	6.940
New lending	1,590,203	0.363	0.480	0	0	1
Term. lending	1,590,203	0.240	0.427	0	0	0
NPL	1,590,203	0.004	0.006	0	0	0.004
Bank Size	1,590,203	22.680	2.317	20.927	23.179	24.623
Bank level						
New lending	24	0.445	0.228	0.271	0.426	0.631
Term. lending	24	0.433	0.242	0.211	0.378	0.659
NPL	24	0.053	0.044	0.023	0.032	0.089
Bank Size	24	20.782	2.332	19.081	19.803	22.674
Firm level						
Fail	338,644	0.270	0.443	0	0	1
Size	338,644	13.478	1.449	12.470	13.369	14.368
Age	338,644	16.392	12.885	8	13	22
Leverage	338,644	0.246	0.220	0.080	0.202	0.424
Collateral	338,644	0.279	0.226	0.089	0.225	0.359

TABLE A.1. Summary statistics

Notes: The table presents summary statistics. *Bank Shock* is the average value of interbank liabilities plus deposits post-shock minus the average value pre-shock, scaled by the average total assets pre-shock and weighted by the bank-firm pre-shock lending relationship. ΔL is the firm-bank logarithmic difference between the post-shock averaged and the pre-shock averaged values of credit granted to firm i by bank b. *New lending* is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. *Term. Lending* is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. *NPL* measures the fraction of loans that are in default as a fraction of the bank's total assets pre shock. *Bank Size* is the time averaged pre crisis natural logarithm of the bank's total assets. *Fail* is a dummy that equals 1 if firm i fails, and 0 otherwise. *Size* is measured by the firm's pre shock logarithm of real total assets. *Age* is calculated as the pre shock number of years since the date of incorporation. *Leverage* is measured as the pre shock firm's total debt to assets ratio. *Collateral* is the ratio of the pre shock firm's tangible assets to its total assets. Variables are measured in thousands of euros.

	(1)	(2)	(3)
Bank Shock	1.867**	1.473**	1.571**
	(2.27)	(2.14)	(1.91)
New Lending		0.846***	1.020***
		(8.66)	(9.64)
Term. Lending		-1.013***	-1.287***
		(-8.92)	(-10.08)
NPL		0.070	0.009
		(1.45)	1.47)
Bank Size		0.004	0.002
		(0.35)	(0.13)
$Z - score$			-3.479***
			(-15.33)
Observations	1,590,203	1,590,203	1,108,271
Firm fixed effects	Yes	Yes	No

TABLE A.2. Bank shock and supply of credit

Notes: The table presents OLS regressions, where the dependent variable is the change between the post-shock averaged and the pre-shock averaged values of credit. *Bank Shock* is the average value of interbank liabilities plus deposits post-shock minus the average value pre-shock, scaled by the average total assets pre-shock and weighted by the bank-firm pre-shock lending relationship. *New lending* is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. *Term. Lending* is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. NPL measures the fraction of loans that are in default as a fraction of the bank's total assets pre shock. $Z - score$ is the time averaged pre crisis firms' probability of default, as measured by the z-score. *Bank Size* is the time averaged pre crisis natural logarithm of the bank's total assets. Robust t-statistics are presented in parentheses. Standard errors are clustered at the bank level. *significant at 10 %; ** significant at 5 %; *** significant at 1 %.

	(1)	(2)	(3)
Bank Shock	-0.563**	-0.589**	-0.507**
	(-2.19)	(-2.26)	(-2.34)
Size	-0.048***	-0.044***	-0.053***
	(-15.90)	(-12.60)	(-12.68)
Age	-0.002***	-0.002***	-0.001***
	(-4.90)	(-5.02)	(-3.54)
Leverage	-0.020	0.044***	-0.020
	(-1.56)	(4.14)	(-1.60)
Collateral	-0.005	-0.014	-0.045***
	(-0.57)	(-1.09)	(-2.97)
New Lending	0.570***	0.545***	0.522***
	(13.83)	(12.50)	(11.31)
Term. Lending	0.160***	0.200***	0.178***
	(8.23)	(8.70)	(8.89)
NPL	0.071*	0.071*	0.076*
	(1.74)	(1.70)	(1.84)
Bank Size	-0.007	-0.009	-0.011
	(-0.57)	(-0.70)	(-0.81)
$Z - score$			0.268**
			(2.23)
Observations	338,644	338,644	252,336
Industry fixed effects	Yes	Yes	Yes
Credit demand	No	Yes	Yes

TABLE A.3. The effect of bank shocks on corporate failures

Notes: The table presents probit regressions, where the dependent variable is a dummy equal to 1 if the firm fails, and 0 otherwise. *Bank Shock* is the average value of interbank liabilities plus deposits post-shock minus the average value pre-shock, scaled by the average total assets pre-shock and weighted by the bank-firm pre-shock lending relationship. *Size* is measured by the firm's pre shock logarithm of real total assets. *Age* is calculated as the pre shock number of years since the date of incorporation. *Leverage* is measured as the pre shock firm's total debt to assets ratio. *Collateral* is the pre shock ratio of the firm's tangible assets to its total assets. *New lending* is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. *Term. Lending* is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. *NPL* measures the fraction of loans that are in default as a fraction of the bank's total assets pre shock. *Bank Size* is the time averaged pre crisis natural logarithm of the bank's total assets. $Z - score$ is the time averaged pre crisis firms' probability of default, as measured by the z-score. *Credit demand* denotes firm-level dummies estimated in the regression reported in Column 2 of Table 2. Robust z-statistics are presented in parentheses. Standard errors are clustered at the bank level. *significant at 10 %; ** significant at 5 %; *** significant at 1 %.

	(1) Credit lines	(2) Z-score	(3) Age
*Bank Shock*Dummy*	-0.636**	-0.702***	-0.819***
	(-2.06)	(-3.15)	(-3.10)
Bank Shock(1 − Dummy)*	-0.307	-0.452	-0.422*
	(-0.91)	(-1.59)	(-1.79)
Size	-0.054***	-0.053***	-0.054***
	(-12.15)	(-12.96)	(-12.51)
Age	-0.001***	-0.001***	-0.002***
	(-3.57)	(-3.52)	(-3.34)
Leverage	-0.019	-0.023*	-0.020
	(-1.50)	(-1.74)	(-1.58)
Collateral	-0.043***	-0.043***	-0.045***
	(-2.75)	(-2.92)	(-2.96)
$Z - score$	0.268**	0.218	0.280**
	(2.26)	(1.58)	(2.35)
New Lending	0.524***	0.521***	0.523***
	(11.18)	(11.30)	(11.35)
Term. Lending	0.179***	0.178***	0.179***
	(8.88)	(8.95)	(8.95)
NPL	0.687*	0.768*	0.741*
	(1.71)	(1.85)	(1.84)
Bank Size	-0.011	-0.011	-0.011
	(-0.81)	(-0.82)	(-0.79)
Observations	252,366	252,366	252,366
Industry fixed effects	Yes	Yes	Yes
Credit demand	Yes	Yes	Yes

TABLE A.4. Firm heterogeneity and bank shocks

Notes: The table presents Probit regressions, where the dependent variable is a dummy equal to 1 if the firm fails, and 0 otherwise. *Bank Shock* is the average value of interbank liabilities plus deposits post-shock minus the average value pre-shock, scaled by the average total assets pre-shock and weighted by the bank-firm pre-shock lending relationship. *Dummy* is a dummy variable that takes the value 1 if the firm has used all available credit (column 1), if the firm's z-score is above the median (column 2) and if the firm's age is below the median (column 3). *Size* is measured by the firm's pre shock logarithm of real total assets. *Size* is measured by the firm's real total assets. *Age* is calculated as the number of years since the date of incorporation. *Leverage* is measured as the firm's total debt to assets ratio. *Collateral* is the ratio of the firm's tangible assets to its total assets. $Z - score$ is the time averaged pre crisis firms' probability of default, as measured by the z-score. *New lending* is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. *Term. Lending* is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. *NPL* measures the fraction of loans that are in default as a fraction of the bank's total assets. *Bank Size* is the log of the total assets of the bank. Robust t-statistics are presented in parentheses. *Zscore* is the time averaged pre crisis firms' probability of default, as measured by the z-score. Standard errors are clustered at the bank level. *significant at 10 %; ** significant at 5 %; *** significant at 1 %.

	(1)	(2)	(3)
CDS	0.473***	0.448***	0.458***
	(6.86)	(7.03)	(6.73)
Size	-0.039***	-0.033***	-0.043***
	(-5.56)	(-4.08)	(-4.72)
Age	0.000	0.000	0.000
	(0.23)	(0.01)	(0.58)
Collateral	-0.030	-0.035	-0.087**
	(-1.20)	(-1.05)	(-2.39)
Leverage	0.040*	0.153***	0.004
	(1.74)	(5.76)	(0.26)
New Lending	0.167***	0.118***	0.100***
	(5.88)	(3.78)	(3.04)
Term. Lending	0.236***	0.360***	0.364***
	(5.65)	(6.44)	(7.20)
NPL	-9.497***	-9.095***	-9.323***
	(-5.63)	(-5.77)	(-5.56)
Bank Size	0.100***	0.087***	0.083***
	(3.72)	(3.47)	(3.13)
Zscore			1.144***
			(6.52)
Observations	84,398	84,398	65,193
Industry fixed effects	Yes	Yes	Yes
Credit demand	No	Yes	Yes

TABLE A.5. The effect of CDS spreads on corporate failures

Notes: The table presents probit regressions, where the dependent variable is a dummy equal to 1 if the firm fails, and 0 otherwise. *CDS* measures banks' CDS spreads. *Size* is measured by the firm's pre shock logarithm of real total assets. *Age* is calculated as the pre shock number of years since the date of incorporation. *Leverage* is measured as the pre shock firm's total debt to assets ratio. *Collateral* is the pre shock ratio of the firm's tangible assets to its total assets. *New lending* is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. *Term. Lending* is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. *NPL* measures the fraction of loans that are in default as a fraction of the bank's total assets pre shock. *Bank Size* is the time averaged pre crisis natural logarithm of the bank's total assets. $Z-score$ is the time averaged pre crisis firms' probability of default, as measured by the z-score. *Credit demand* denotes firm-level dummies estimated in the regression reported in Column 2 of Table 2. Robust z-statistics are presented in parentheses. Standard errors are clustered at the bank level. *significant at 10 %; ** significant at 5 %; *** significant at 1 %.

	(1) Credit lines	(2) Z-score	(3) Age
CDS*$Dummy$	0.483***	0.461***	0.470***
	(5.73)	(6.74)	(15.25)
CDS*$(1-Dummy)$	0.498***	0.456***	0.456***
	(5.17)	(6.75)	(14.98)
$Size$	-0.048***	-0.044***	-0.039***
	(-4.45)	(-4.98)	(-5.11)
Age	0.000	0.000	0.002***
	(0.59)	(0.51)	(4.53)
$Leverage$	0.016	0.015	0.002
	(1.00)	(0.98)	(0.09)
$Collateral$	-0.075*	-0.092***	-0.089***
	(-1.71)	(-2.61)	(-3.18)
$Z-score$	1.193***	1.315***	1.071***
	(6.12)	(5.07)	(6.97)
$New\ Lending$	0.115***	0.101***	0.094***
	(2.93)	(3.00)	(5.13)
$Term.\ Lending$	0.379***	0.364***	0.360***
	(7.16)	(7.15)	(28.15)
NPL	-10.347***	-9.308***	-9.345***
	(-4.46)	(-5.58)	(-18.20)
$Bank\ Size$	0.088***	0.083***	0.084***
	(3.10)	(3.14)	(7.69)
$Observations$	65,193	65,193	65,193
$Industry\ fixed\ effects$	Yes	Yes	Yes
$Credit\ demand$	Yes	Yes	Yes

TABLE A.6. Firm heterogeneity and CDS spreads

Notes: The table presents probit regressions, where the dependent variable is a dummy equal to 1 if the firm fails, and 0 otherwise. CDS measures banks' CDS spreads. $Dummy$ is a dummy variable that takes the value 1 if the firms has used all available credit (column 1), if the firm's z-score is above the median (column 2) and if the firm's age is below the median (column 3). $Size$ is measured by the firm's pre shock logarithm of real total assets. $Size$ is measured by the firm's real total assets. Age is calculated as the number of years since the date of incorporation. $Leverage$ is measured as the firm's total debt to assets ratio. $Collateral$ is the ratio of the firm's tangible assets to its total assets. $Z-score$ is the time averaged pre crisis firms' probability of default, as measured by the z-score. $New\ lending$ is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. $Term.\ Lending$ is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. NPL measures the fraction of loans that are in default as a fraction of the bank's total assets. $Bank\ Size$ is the log of the total assets of the bank. Robust t-statistics are presented in parentheses. Standard errors are clustered at the bank level. *significant at 10 %; ** significant at 5 %; *** significant at 1 %.

	(1)	(2)	(3)
Sov. Exposure	0.045***	0.046***	0.032**
	(3.23)	(3.14)	(1.99)
Size	-0.090***	-0.091***	-0.057***
	(-4.99)	(-4.34)	(-3.36)
Age	-0.001	-0.001	-0.001***
	(-0.79)	(-0.84)	(-3.18)
Collateral	0.085	0.080	-0.047**
	(1.40)	(1.33)	(-2.74)
Leverage	-0.075	-0.013	-0.022
	(-1.00)	(-0.15)	(-1.65)
New Lending	0.580***	0.561***	0.498***
	(10.11)	(9.56)	(10.57)
Term. Lending	0.250***	0.311***	0.163***
	(4.14)	(4.98)	(6.94)
NPL	0.656***	0.644***	0.336
	(3.72)	(3.30)	(0.88)
Bank Size	0.035	0.036	0.018
	(1.20)	(1.21)	(1.32)
Zscore			0.216*
			(1.77)
Observations	290,419	290,419	217,095
Industry fixed effects	Yes	Yes	Yes
Credit demand	No	Yes	Yes

TABLE A.7. The effect of sovereign exposure on corporate failures

Notes: The table presents probit regressions, where the dependent variable is a dummy equal to 1 if the firm fails, and 0 otherwise. *Sov. Exposure* measures banks' sovereign holdings as a fraction of their total assets. *Size* is measured by the firm's pre shock logarithm of real total assets. *Age* is calculated as the pre shock number of years since the date of incorporation. *Leverage* is measured as the pre shock firm's total debt to assets ratio. *Collateral* is the pre shock ratio of the firm's tangible assets to its total assets. *New lending* is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. *Term. Lending* is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. *NPL* measures the fraction of loans that are in default as a fraction of the bank's total assets pre shock. *Bank Size* is the time averaged pre crisis natural logarithm of the bank's total assets. $Z - score$ is the time averaged pre crisis firms' probability of default, as measured by the z-score. *Credit demand* denotes firm-level dummies estimated in the regression reported in Column 2 of Table 2. Robust z-statistics are presented in parentheses. Standard errors are clustered at the bank level. *significant at 10 %; ** significant at 5 %; *** significant at 1 %.

	(1) Credit lines	(2) Z-score	(3) Age
*Sov. Exposure*Dummy*	0.034**	0.040**	0.034***
	(2.01)	(2.12)	(5.28)
Sov. Exposure(1 − Dummy)*	-0.076*	0.025	0.029***
	(-1.65)	(1.56)	(3.88)
Size	-0.057***	-0.058***	-0.058***
	(-13.43)	(-13.34)	(-5.57)
Age	-0.001***	-0.001***	-0.001***
	(-3.19)	(-3.16)	(-3.44)
Leverage	-0.022*	-0.023*	-0.022
	(-1.65)	(-1.66)	(-0.65)
Collateral	-0.048***	-0.047***	-0.048**
	(-2.74)	(-2.73)	(-2.15)
$Z - score$	0.218*	0.207*	0.216
	(1.79)	(1.70)	(1.00)
New Lending	0.497***	0.498***	0.499***
	(10.59)	(10.58)	(66.27)
Term. Lending	0.166***	0.164***	0.163***
	(7.14)	(6.94)	(29.01)
NPL	0.344	0.337	0.337***
	(0.91)	(0.88)	(18.12)
Bank Size	-0.019	-0.019	-0.019***
	(-1.36)	(-1.33)	(-3.73)
Observations	217,095	217,095	217,095
Industry fixed effects	Yes	Yes	Yes
Credit demand	Yes	Yes	Yes

TABLE A.8. Firm heterogeneity and sovereign exposure

Notes: The table presents probit regressions, where the dependent variable is a dummy equal to 1 if the firm fails, and 0 otherwise. *Sov. Exposure* measures banks' sovereign holdings as a fraction of their total assets. *Dummy* is a dummy variable that takes the value 1 if the firms has used all available credit (column 1), if the firm's z-score is above the median (column 2) and if the firm's age is below the median (column 3). *Size* is measured by the firm's pre shock logarithm of real total assets. *Size* is measured by the firm's real total assets. *Age* is calculated as the number of years since the date of incorporation. *Leverage* is measured as the firm's total debt to assets ratio. *Collateral* is the ratio of the firm's tangible assets to its total assets. $Z - score$ is the time averaged pre crisis firms' probability of default, as measured by the z-score. *New lending* is a dummy equal to 1 if the firm has a loan from a bank that it had no relationship pre shock, and 0 otherwise. *Term. Lending* is a dummy equal to 1 if a bank has terminated an existing relationship as of 2009, and 0 otherwise. NPL measures the fraction of loans that are in default as a fraction of the bank's total assets. *Bank Size* is the log of the total assets of the bank. Robust t-statistics are presented in parentheses. Standard errors are clustered at the bank level. *significant at 10 %; ** significant at 5 %; *** significant at 1 %.

Working Papers

2016

1|16 A mixed frequency approach to forecast private consumption with ATM/POS data
Cláudia Duarte | Paulo M. M. Rodrigues | António Rua

2|16 Monetary developments and expansionary fiscal consolidations: evidence from the EMU
António Afonso | Luís Martins

3|16 Output and unemployment, Portugal, 2008–2012
José R. Maria

4|16 Productivity and organization in portuguese firms
Lorenzo Caliendo | Luca David Opromolla | Giordano Mion | Esteban Rossi-Hansberg

5|16 Residual-augmented IVX predictive regression
Matei Demetrescu | Paulo M. M. Rodrigues

6|16 Understanding the public sector pay gap
Maria M. Campos | Evangelia Papapetrou | Domenico Depalo Javier J. Pérez | Roberto Ramos

7|16 Sorry, we're closed: loan conditions when bank branches close and firms transfer to another bank
Diana Bonfim | Gil Nogueira | Steven Ongena

8|16 The effect of quantitative easing on lending conditions
Laura Blattner | Luísa Farinha | Gil Nogueira

9|16 Market integration and the persistence of electricity prices
João Pedro Pereira | Vasco Pesquita | Paulo M. M. Rodrigues | António Rua

10|16 EAGLE-FLI | A macroeconomic model of banking and financial interdependence in the euro area
N. Bokan | A. Gerali | S. Gomes | P. Jacquinot | M. Pisani

11|16 Temporary contracts' transitions: the role of training and institutions
Sara Serra

12|16 A wavelet-based multivariate multiscale approach for forecasting
António Rua

13|16 Forecasting banking crises with dynamic panel probit models
António Antunes | Diana Bonfim | Nuno Monteiro | Paulo M. M. Rodrigues

14|16 A tale of two sectors: why is misallocation higher in services than in manufacturing?
Daniel A. Dias | Carlos Robalo Marques | Christine Richmond

15|16 The unsecured interbank money market: a description of the Portuguese case
Sofia Saldanha

16|16 Leverage and risk weighted capital requirements
Leonardo Gambacorta | Sudipto Karmakar

17|16 Surviving the perfect storm: the role of the lender of last resort
Nuno Alves | Diana Bonfim | Carla Soares

18|16 Public debt expansions and the dynamics of the household borrowing constraint
António Antunes | Valerio Ercolani

2017

1|17 The diffusion of knowledge via managers' mobility
Giordano Mion | Luca David Opromolla | Alessandro Sforza

2|17 Upward nominal wage rigidity
Paulo Guimarães | Fernando Martins | Pedro Portugal

3|17 Zooming the ins and outs of the U.S. unemployment
Pedro Portugal | António Rua

4|17 Labor market imperfections and the firm's wage setting policy
Sónia Félix | Pedro Portugal

5|17 International banking and cross-border effects of regulation: lessons from Portugal
Diana Bonfim | Sónia Costa

6|17 Disentangling the channels from birthdate to educational attainment
Luís Martins | Manuel Coutinho Pereira

7|17 Who's who in global value chains? A weighted network approach
João Amador | Sónia Cabral | Rossana Mastrandrea | Franco Ruzzenenti

8|17 Lending relationships and the real economy: evidence in the context of the euro area sovereign debt crisis
Luciana Barbosa

9|17 Impact of uncertainty measures on the Portuguese economy
Cristina Manteu | Sara Serra

10|17 Modelling currency demand in a small open economy within a monetary union
António Rua

11|17 Boom, slump, sudden stops, recovery, and policy options. Portugal and the Euro
Olivier Blanchard | Pedro Portugal

12|17 Inefficiency distribution of the European Banking System
João Oliveira

13|17 Banks' liquidity management and systemic risk
Luca G. Deidda | Ettore Panetti

14|17 Entrepreneurial risk and diversification through trade
Federico Esposito

15|17 The portuguese post-2008 period: a narrative from an estimated DSGE model
Paulo Júlio | José R. Maria

16|17 A theory of government bailouts in a heterogeneous banking system
Filomena Garcia | Ettore Panetti

17|17 Goods and factor market integration: a quantitative assessment of the EU enlargement
FLorenzo Caliendo | Luca David Opromolla | Fernando Parro | Alessandro Sforza

2018

1|18 Calibration and the estimation of macro-economic models
Nikolay Iskrev

2|18 Are asset price data informative about news shocks? A DSGE perspective
Nikolay Iskrev

3|18 Sub-optimality of the friedman rule with distorting taxes
Bernardino Adão | André C. Silva

4|18 The effect of firm cash holdings on monetary policy
Bernardino Adão | André C. Silva

5|18 The returns to schooling unveiled
Ana Rute Cardoso | Paulo Guimarães | Pedro Portugal | Hugo Reis

6|18 Real effects of financial distress: the role of heterogeneity
Francisco Buera | Sudipto Karmakar

7|18 Did recent reforms facilitate EU labour market adjustment? Firm level evidence
Mario Izquierdo | Theodora Kosma | Ana Lamo | Fernando Martins | Simon Savsek

8|18 Flexible wage components as a source of wage adaptability to shocks: evidence from European firms, 2010–2013
Jan Babecký | Clémence Berson | Ludmila Fadejeva | Ana Lamo | Petra Marotzke | Fernando Martins | Pawel Strzelecki

9|18 The effects of official and unofficial information on tax compliance
Filomena Garcia | Luca David Opromolla Andrea Vezulli | Rafael Marques

10|18 International trade in services: evidence for portuguese firms
João Amador | Sónia Cabral | Birgitte Ringstad

11|18 Fear the walking dead: zombie firms, spillovers and exit barriers
Ana Fontoura Gouveia | Christian Osterhold

12|18 Collateral Damage? Labour Market Effects of Competing with China – at Home and Abroad
Sónia Cabral | Pedro S. Martins | João Pereira dos Santos | Mariana Tavares

13|18 An integrated financial amplifier: The role of defaulted loans and occasionally binding constraints in output fluctuations
Paulo Júlio | José R. Maria

14|18 Structural Changes in the Duration of Bull Markets and Business Cycle Dynamics
João Cruz | João Nicolau | Paulo M.M. Rodrigues

15|18 Cross-border spillovers of monetary policy: what changes during a financial crisis?
Luciana Barbosa | Diana Bonfim | Sónia Costa | Mary Everett

16|18 When losses turn into loans: the cost of undercapitalized banks
Laura Blattner | Luísa Farinha | Francisca Rebelo

17|18 Testing the fractionally integrated hypothesis using M estimation: With an application to stock market volatility
Matei Demetrescu | Paulo M. M. Rodrigues | Antonio Rubia

18|18 Every cloud has a silver lining: Micro-level evidence on the cleansing effects of the Portuguese financial crisis
Daniel A. Dias | Carlos Robalo Marques

19|18 To ask or not to ask? Collateral versus screening in lending relationships
Hans Degryse | Artashes Karapetyan | Sudipto Karmakar

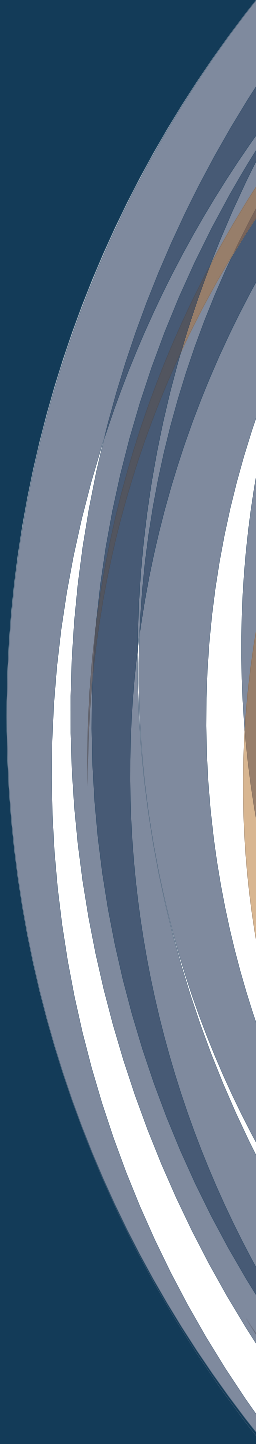
20|18 Thirty years of economic growth in Africa
João Amador | António R. dos Santos

21|18 CEO performance in severe crises: the role of newcomers
Sharmin Sazedj | João Amador | José Tavares

22|18 A general equilibrium theory of occupational choice under optimistic beliefs about entrepreneurial ability
Michele Dell'Era | Luca David Opromolla | Luís Santos-Pinto

23|18 Exploring the implications of different loan-to-value macroprudential policy designs
Rita Basto | Sandra Gomes | Diana Lima

24|18 Bank shocks and firm performance: new evidence from the sovereign debt crisis
Luísa Farinha | Marina-Eliza Spaliara | Serafem Tsoukas



www.bportugal.pt